January 11, 1979

the
CANNON

University of Toronto Engineering Society

ISSUE

Steam on efficient lines

by Professor M. W. Thring, Dr J. E. Shorpe ond P. K. Le Sueur, Department of Mechanicol Engineering, Queen Mory College, University of London

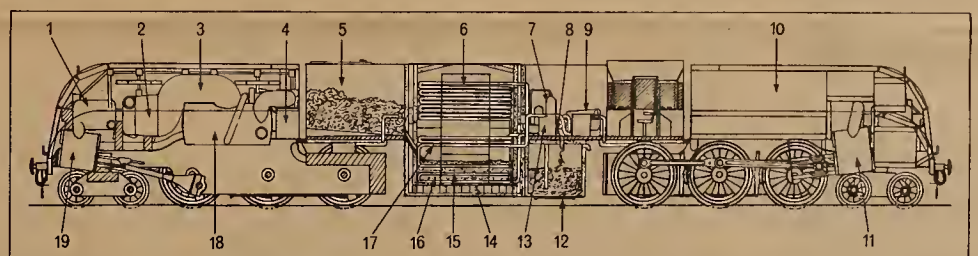
Fluidized-bed combustion, now seen os revolutionizing cool-fired power stotions, sould chonge the face of railwoys ond bring back the steam locamotive.

When the steom railway locomotive reached the peak of its development, in the 1930's, it was only o step oway from those of eorly 19th-century design, though bigger ond more powerful, engines of the sort, with hardly any updoting, still run today. It is no wonder that the emergence of diesel and electric locomotives led people in the industriolized countries to regord steam locomotives as old-foshioned and obsolete. Other countries followed the trend, with a few notable exceptions, ond steam rapidly began to disappear from the world's roilwoys.

This, no doubt, would hove been the end of the story, except for one vitol factor—the energy crisis, ond the oil shortage in particular. Without oil, ot least with present technology, there could be no motor-cars in their traditional form ond no aeroplones. Ships could return to steam propulsion. The world would be heavily dependent upon its railwoys for land transport, but without oil for the diesel locomotives. Electrification, using coal-burning or nuclear power stations is one answer, but there are many railways that would be prohibitively expensive to electrify. For these, another form of power would be needed.

To raise steam is easy but, to many, the ideo of actuolly going back to this tradition is repellent. True, the steom locomotive wos dirty ond smelly; its osh hod to be emptied and it needed stoking, oiling ond lighting up hours before it began to work. Its thermol efficiency wos at best only eight per cent, but it did hove many odvantages often overlooked today: it wos reliable, its failures seldom leading to complete immobility; it could produce a vost, instantaneous power, and it lasted seemingly for ever. It was also capable of running with remorkobly little overhaul (though at the expense of efficiency), o foct appreciated in countries where skilled fitters were few and fuel was plentiful. But, most important of all, it could run on anything that could be burnt, including coal, oil, wood, gas, peat and sugar-beet.

Here, then, is one possible form of railway power for the future. But we need o steam locomotive that has all the importont advantoges and none of the big disadvantages of the conventional machine. Above all, it should have a thermal efficiency comparable with thot of diesel and electric locomotives.



1 Compressor	5 Coal bunker	9 Auxiliary turbine	13 Heat accumulator	17 Superheater tubes
2 Turbine	6 Feed heater tubes	10 Radiator panels	14 Distributor plate	18 Condenser
3 Exhaust branch	7 Starting gas cylinder	11 LP cylinder	15 Bed evaporative tubes	19 HP cylinder
4 Hot well	8 Feed pump	12 Emptying hatch	16 Fluidized bed	

Sectional elevation of the proposed locomotive. It is designed for a maximum continuous power output of 2·5 MW with an overall thermal efficiency of 24·5 per cent. Overall length is 27 m with other dimensions to comply with the standard British loading gauge.

Modelling

Our reseorch project, sponsored by the UK Science Reseorch Council, is concerned with the mothermoticol modelling of steam cycles that could be applied to an advanced, efficient steam railway locomotive. We are using digitol and anologue computers. Our aim is to find out the dynamic behaviour of the various systems and to use the information in designing the control system, which, becouse the mochine we envisoge is so complex, will be for more complicoted than one for a conventional steom locomotive. Although we hove not yet completed the mathematical model, a very promising design of locomotive has already emerged. Here, we are concerned with describing this machine and the reosoning that led to it toking its present form.

Our main aim was to design a locomotive that would burn coal instead of oil. Cool-burning gos turbines were considered but there are big problems of erosion of their blades. It soon become clear

cont. on pg. 2

THE LURE OF THE SEA

DOWN TO THE SEA IN SIMULATORS

cont. from last issue.

Every reaction is logged by the computer and the ship's course is troced automatically on on x-y plotter. The post-mortem examination is quick, accurate and strict for there is no arguing with the record. Now the instructor decides to repeat the final stage of the exercise, so the computer is token bock by 20 minutes to the moment when the second ship is first found by rador. The bridge crew find themselves making decisions agoin, this time with the instructor's criticisms fresh in their minds. They avoid collision by a larger margin. The instructor relents and lifts his fog-bank. But, as a buoyed sandbank appears close to starboard, he sees fit to jam the steering gear amidships...

Such o troining device hos tremendous flexiblity. Exercises of any required degree of difficulty can be set up in a short time and repeated as often as is necessory. Emergencies can be arringed, to take bridge teams through the correct drill, thereby ensuring thot when similar things happen in real life they will react correctly without hesitoting.

tension

Of course, the critics say, "It's not the reol thing, the troinees know they don't need to

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Steam power

that on expansion engine using a conventional Rankine cycle, with water for the working fluid, would be the best choice. Other fluids could be used, but their merits are small compared with their cost, scarcity, and danger in use.

Having decided on a steam locomotive, our next step was to find ways to raise its thermal efficiency from the usuol eight per cent to the diesel's 20 per cent or so. With a Rankine cycle, this can be done in two ways, by raising the boiler pressure and by reducing the engine exhaust pressure. Railway engineers had appreciated this in the 1920s and 1930s, when many unconventional locomotives had been designedin ottempts to attain a better overall cycle efficiency by one or other of these means. An exhaustive study revealed a vast number of weird machines, some quite successful, others less so.

Water-Tube Boiler

To raise the boiler pressure above about 2 MPa (megapascals) needed a water-tube rather than a fire-tube boiler. This allowed very high pressures to be used, but to keep the temperatures to a reasonable level for a long boiler life, we finally settled on a mean pressure of 4•5 MPa. We had to reduce the exhaust pressure and, bearing in mind that a conventional steam locomotive exhausts to the atmosphere, in this instance we had ta arrange to exhaust steam. This meant condensing the exhaust steam. The lower the condenser pressure, the higher the cycle eficiency, so we chose a pressure of 7 kPa (kilopascals), because this gave us the lowest condenser temperature that would still allow cooling by atmospheric air.

We planned to pump the condensate back to the boiler, which meant complete recycling of the water, apart from the small steam losses through glands and stuffing boxes, so we could use softened water to contribute to long boiler life.

The next aim was to ensure pollution-free combustion at moximum effiiency, with automatic stoking and ash removal. All this could be achieved by employing fluidized-bed combustion. A fluidized bed comprises a quantity of inert material, such as sand, supported on a perforated 'distributor plate'. When air is blown through the plate, large bubbles form and agitate the bed, causing it to bubble up and behove rather like a boiling liquid. In this instance, the motion of the locomotive would aid the fluidization. Coal sprinkled on such a bed burns ot obout 900°C and very efficiently heats evaporation tubes immersed in the bed. The hot gases leaving the bed can be used in gas turbines, but for reasons already stated we planned to use them to superheat the steam instead, and to heat the feed water.

A fluidized bed produces virtually no pollution. Its temperature is too low for ash to fuse or for impurities such as potassium and sodium to vaporize, while the large amount of excess air in it prevents carbon monoxide forming. Adding limestone to the sand stops sulphur dioxide being given off.

Ash is removed by blasting the mixture of sand and ash from the bed into o cyclone, with and injector operated by bleeding off some of the fluidizing oir. Separated by centrifugal oction, the ash rises in the cyclone and is deposited into .an ash well ready for emptying. The sand falls into o sand well and is returned to the bed by another air injector.

The bed does not need expensive pulverizing machinery. It can burn coal in lumps of any size up to 25 mm and, with only simple adjustments, can be made to burn any other fuel. A hopper or screw is all that is needed ot feed in the fuel, which spreads itself across the bed; this is in contrast to the accurate stoking that an ordinary grate needs. The combustion efficiency is better than 98 per cent and the bed can be started up from cold in about 30 minutes, using propane gas mixed with the fluidizing air and ignited by an electric spark.

For railway traction it is necessary to have a large starting torque, with lower torques at running speeds. Reciprocating steam locomotives always provided this, which is why we chose a reciprocating engine for our design. However, at the low-pressure end of the cycle the volume of the steam is so enormous that reciprocating engines cannot handle it. A turbine can accept far larger volume flow rates and is ideally suited to the low-pressure end, but it develops its maximum torque at its top speed, which, as had been found in the past, means having a complicated gear box or an intermediate transmission system, either electrical or hydraulic, to adapt it to locomotion.

Trying to match the direct high-pressure cylinder drive with a low-pressure turbine and associated transmission was soon found to be highly undesirable. Therefore, we adopted a system originally invented by Gotaverken, o company in Sweden, for use of steamships. It uses the turbine power to drive a steam compressor, ch[illegible]n compresses and reheats the steom between the high-pressure and low-pressure cylinders of the reciprocating engine. The theoretical loss through using mechanicol power to heat the steam is less than the loss in turbine transmission used for propulsion. Furthermore, if we had to use a reheater to replace the compressor, it would entail taking the steam from the high-pressure cylinders and feeding it to the boiler and then back to the low pressure cylinders, thereby incurring large heat losses in pipes and so on.

So, we see that the turbo-compressor system is a convenient, practical way of utilizing the full heat drop that tokes place as the steam falls to the condenser pressure, without making the locomotive more mechanically complicoted. It allows the well-tried Beyer-Garrett articulated arrangement to be used, with a central steam-roising unit providing steam for two identical engine units.

Cooling

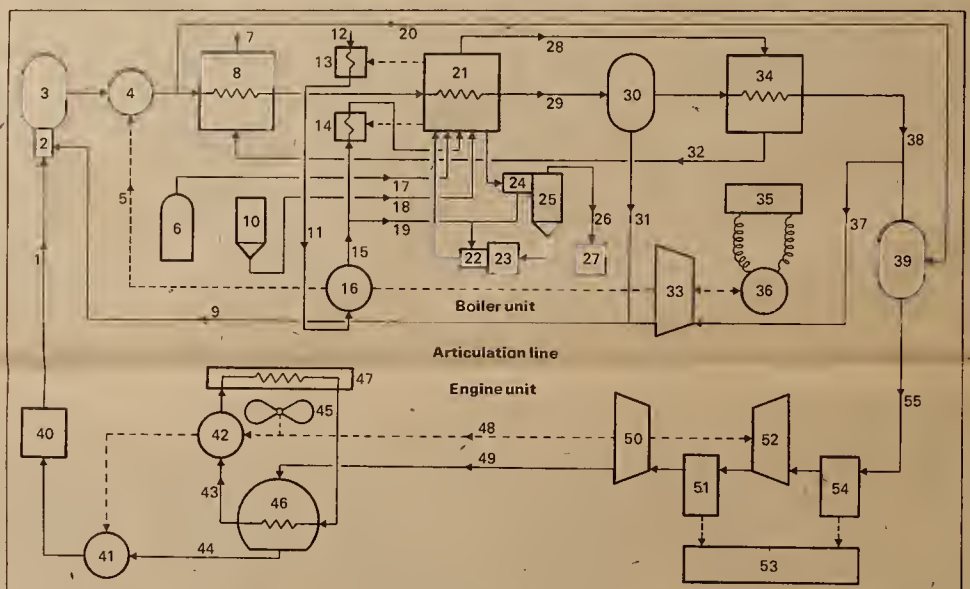
In our proposed system, each engine unit condenses its own steam in a conventional shell-and-tube condenser cooled by circulating water. The water is cooled in radiators built around the outer shell of the locomotive, by the surounding air. Of all the condensing systems used in locomotives in the past, this one has proved the most successful; the total space it takes is far less than when direct air-cooled condensers are used, because the heat transfer is better. These condensers can also provide the heating for the train.

The turbines also drive the rodiator cooling fans, the cooling-water pumps and the 'wet-air' pumps but, to make the boiler unit self-contained, ond ouxiliary turbine is included to drive the blower for fluidizing the bed and the reciprocating feed pump. A direct-current motor drives the blower when starting from cold, drawing its supply from batteries which are recharged by the same machine working as a generator when the auxiliary turbine is running. The auxiliary turbine exhaust is mixed with the incoming feed water to provide first-stage feed heating.

One problem with water-tube boilers is their very quick response to changes in heat, but this is an advantage in a locomotive because the power requirements change rapidly. In fact, the engine response times will be even shorter than those of the boiler, so the steam supply must keep pace with them. In a conventional steam locomotive the reservoir effect of the boiler copes with this. In our machine it is managed by a heat 'accumulotor', contoining steam and water under pressure, after the evoporative coils. It also dries the steom, which then passes through the superheater and into a desuperheater, a device to regulate the quality of the steam whenever this becomes necessary before it reaches the engines. In addition, o large hot well at each end of the locomotive enables the water supply to be regulated.

Control

The locomotive is designed to be controlled by only one lever,in cddition to the 'dead man's handle' and the brakes. The lever activates a hydraulic control system, synchronizing the operation of the locomotive's various parts. The cylinders' poppet valves and cut-off controls are intended to be hydraulically operated, too. If anything should fail, the driver could over-ride the outomatic system and continue operating the undamaged parts of the locomotive by means of a complete set of



1	Feed water	12	Air in	23	Sand well	34	Supetheater
2	Water injector	13	1st stage ait pre-heater	24	Sand injector	35	8atteties
3	Bled steam mixer	14	2nd stage ait pre-heater	25	Cyclone	36	DC Machine
4	Feed pump	15	Warm air	26	Ash	37	Bled steam
5	Power to pumps	16	Air blower	27	Ash well	38	Dry steam
6	Starting gas cylinder	17	Gas	28	Hot gas	39	De-superheater
7	Exhaust	18	Coal	29	Wet steam	40	Hot well
8	Feed heater	19	Air	30	Heat accumulator	41	Wet ait pump
9	Wet exhaust steam	20	Cold water	31	Drain water	42	Circulating pump
10	Coal bunker	21	Fluidized bed	32	Hot gas	43	Cooling water
11	Warm ait	22	Sand ejector	33	Auxiliary turbine	44	Condensate

45	Air fan	48	Power to pumps
46	Condenser	49	Wet steam
47	Radiators	50	Compressor
		51	LP cylinders
		52	Turbine
		53	Wheels and train
		54	HP cylinder
		55	Live steam

Block diagram of the proposed cycle. For simplicity, only one engine unit is shown.

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Associate Editors: Dana Williams, Rob Pupulin, Pete Rankin

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manual contrals.

Our wark an the ecanamics of the locomotive proves that it would be superiar in all ways to diesel and electric traction. First and foremost, its averall thermal efficiency has been calculated as 24•5 per cent. This is equivalent ta a diesel locamotive's peak efficiency, but if we plat our lacomotive's efficiency against speed the curve is flatter than a diesel's, which means that our machine wauld be the mare efficient aver mast of the range of operating speeds. The efficiency of a caal-fired power statian is slightly greater than the locomotive's, but when we take into accaunt an entire electrical system, including distribution lines and trains, as well as the power station itself, the steam locomative has a higher overall thermal efficiency.

The capitol cast would be less than that of a diesel, which has o large, camplex engine. All the steam-cycle components are ovailable 'off the shelf', and have been tried and tested in other branches of engineering. It would be cheoper than an electric system, of course. which has to include the electric canductar and installations. The steam machine wauld need no mare maintenance than a diesel does; it would be cleaner and wauld produce less pollutian, as already explained. It wauld be mare reliable too, rarely stopping dead as a diesel does when it breaks dawn, or on electric locomotive when the overhead wires foll down. What is more, the eyesore of miles af averhead wires and catenary masts would be avoided.

The locamative we are naw studying is a 2•S MW (3 3S0 horse-pawer) express freight and semi-fast passenger locamative. It wauld be ideally suited to such duties, particularly an the sart of lang hauls faund in India, Australia, Russia, China, Africa and the Americas, where electrification is unlikely ta be worth while. It might have applications in Eurape, taa.

The cycle wauld be adapted far express passenger lacomotives, probably, by using an all-turbine, or engine-block drive, to remave the 'hamer-blaw' effect of the autside cylinders. a small branch line lacomotive cauld be built by adding o bailer and cab to one of the engine units af the articulated locamative, aver an extra bagie, farming a 4-6-4 tank lacomotive. A similar cycle, using o smaller bailer and a high-speed engine block, would be ideal for a light railcar of the sart used on local passenger duties.

We believe that, combined with electrified suburban systems (ane area where the steam locamotive wauld nat be suitable, awing ta its slawer acceleration), the lacamatives we have outlined cauld pravide all the mative pawer needed by the railwoys af the warld.

cont. from pg. 1

simulators

warry." But experience shaws that in a properly designed exercise the mental tensian an the simulated bridge is very real, and that afficers under training show all the usual symptams of psychalagical stress. in crises. Haw real the bridge layout and fittings appear does not sem ta be critical. In the decca simulator, for instonce, the view is confined ta an arc of little more than S0 degrees on either side af the bow, whereas in o reol ship it extends all round; but the orc takes in most af the goings an important to navigotars and the restrictian does not seem ta hove a great effect an the reality of the exercises. Peripheral feotures such as apparent engine naise and deck vibratian hove been found ta make an important contribution ta the illusion. Attention to these background effecs, which are anly semi-consciausly or even subconsciausly sensed, is essential to good simulator design.

Nobady can claim, af caurse, that simulotor training is a camplete substitute for experience in the job (though tin the case af the Moon astronauts it had to be just that). Nevertheless, for a mariner, simulator training can be a very valuable supplement ta experience. What is mare, it is rapid and economically cound. For some purposes, notably emergency drills, the simulatar is prabably better, because real emergencies cannat be arranged and repeated at will.

the heart of the simulatar is the computer, braught ta life by the mathematical madel af the ship and its surraundings. In essence, the madel is o set af equatians linking velocities and accelerations with the farces acting an the ship. THe basic equatians are thase which opply the secand low af Newtan ta the matian af a rigid body with six axes af freedam. In the case af a ship we need consider anly three: horizantal motion in the fore- and -aft direction, known as surge; horizantal matian at right angles to this, known as sway; and angular matian about a vertical axis, knaxn as yaw. The farces ore those which are imposed an the ship, namely propeller thrust, rudder, wind and tug farces, and the various drag farces arising from the matian af the hull through the water. It is easy to write dawn the equations in a generol form, but proctical difficulties arise when the variaus caefficients (the numbers by which the variables are multiplied) have to be inserted. They cannot yet be predicted, so the values far o given ship have ta be faund experimentolly. Doing this on the ship itself would be prohibitively expensive; in proctice it is quicker and cheoper ta get the informotion fram experiments with scole models.

Obtoining Data

Mathemoticol dota far the Decca simulatar were obtained by the Natianal Maritime Institute, o laboratary of the UK Department af Industry. A variety of techniques hove been used, all invalving in one way or another a turning ar oblique movement af the madel. To discover certain coefficients it is canvenient to taw the model thraugh the water in a straight path at a fixed angle of yaw; far others it is forcibly houled round o circular poth by o rotating arm. For the accelerotion caefficients the model can be made to oscillate sideways os it advances thraugh the water, tracing aut a sinuaus path. Lastly, a completely unrestricted madel can be aperated under radia cantral, conducting manaeuvres typical af a real ship while instruments manitor its caurse and behaviaur. At the NMI all four meons are used and the results are compared with data fram full-scale ship trials wherever they become available; sa far, madel and ship data have agreed remarkably well, reinfarcing faith in the technique of using a model.

Because the woter forces an the ship depend nat just on velacities but an accelerations taa, experiments dane at constant speeds do not give enough information. The depth af water under the keel alsa has a big effect on these farces; a ship's handling characteristics ore changed, sametimes drastically, by the effects af shallow water. NMI's experiments take account af this and shallow woter effects ore built into the computer model.

Digital

The camputer itself is entirely digitol. In early simulators, analogue computers were used ta simulate motions specified by differential equations, but they can be inflexible and voriable in performance. Now, techniques enable digital computers to handle continuously-varying quantities and NMI made use of ane such technique in their program. known as RASP (Real Time anologue Simulotion Program), it has been embodied in the Decca Simulotor and has made possible an extremely flexible model which is capable of representing ony vessel fram the smallest caaster to the largest tanker afloat; ta change fram one vessel to another invalves no more thon the replacement of a tape cossette. Mareover, the performance of any particular ship is fixed and repeatable.

It is important to reproduce the handling characteristics af ships accurately. Experienced ships' officers, and particularly pilats, ore very quick ta spat unrepresentotive features. As a small example, when an early mathematical model was being tried aut during the development af the simulatar, mariners invited ta camment candemned the ship as 'dead'. Although the response ta helm was accurote, it showed nane af the random 'wander' that gusts of wind and turbulence in the water cause. By a simple electricol modificatian, a small law-frequency naise signal was injected into the control loop and the mariners were pleased. "Now she's alive!" wos the verdict, "This is just like a real ship." Small background features such as those already mentianed are absolutely essential if the simulation is to be canvincing.

The Decca simulator went into service in the spring of 1977 and has been hard at wark ever since. In the training, emphasis is on teams rather than individuals; some shipowners make a point of sending groups of officers wha will loter have ta work tagether in the same ship. So far, the machine hos been used exclusively for training deck officers, though it is passible that it may in due course be used for research into, for example, prolems of bridge design, or far assessing collisian-avaidance procedures. But it was designed specifically for troining, and this should be remembered when camparing it with more eloborate machines built elsewhere for research. This is why it has been planted on the compus af o nautical callege, where a ship simulotor is one teoching tool omong many; to be effective it should be used in parallel with blackboard, training launch ond radar plot simulatar. Isolated from nautical teoching in general it connot be wholly effective.

What af the future? The simulator has been developed and proved, and the builders con moke more, each complete in a pair of portoble cabins and in full working arder, needing no more thon connecting up ta a pawer supply.

A parallel development by Morcani Radar allaws the paint-light night-time picture ta be replaced by a televisian display, in calaur, of a full daylight scene. Here, taa, the basic data are held in digital farm, in a camputer which allaws the ship ta be maved abaut in three dimensians relative ta the scene, sa thot the bridge team can steam araund an islond, laaking at it fram all sides, while variaus ships sail post. At a tauch, the contrals bring dawn mist, fog, twilight or night.

Mining for heat

by Dr E.R. Oxburgh, Department of Geology and Mineralogy, University of Oxford

There ore many parts of the world where geothermol heat con be hornessed to produce electricity or to supply hot water direct to dwellings ond factories. In some places it is relatively easy to tap; in others it is won only by costly investment in 'heot mining'. But advancing technology might well bring about o rapid growth in its use.

The temperature at the Earth's surface varies fram place ta place and fram time to time, fram abaut 3S° *C* to —3S°C. At a depth af 10 km it varies from obaut 80°C to 1000°C fram place ta place, but at any ane place it changes very little with time. In fact, the surface ond sub-surfoce temperatures da nat offect each other much. The farmer depends an climate: the large amaunt af salar heot absorbed at the Earth's surface penetrates only a few metres ond is, sa for as can be measured, exactly balanced by that reradioted into space. Sub-

cont. an pg. 4

The surface of the Earth is made up of a series of rigid plates, some 100 km thick. They are continually moving with respect to each other and volcanic activity is concentrated along their margins, where nearly all of the world's geothermal power stations are sited. In this diagram the double lines signify the so-called mid-ocean ridges, the serrated lines represent trenches and the single lines denote faults where the plates slip past each other. Letters identify the various plates, as follows. A: American plate; Aa: Antaretic plate; Ab: Arabian plate; Af: African plate; C: Cocos plate; Ca: Caribbean plate; E: Euraslan plate; I: Indian plate; N: Nazca plate; P: Pacific plate; Ph: Philippine plate. The shaded area is known as the Alpine-Himalayan tertiary collision zone and S marks the Scotia arc.

Engineering Society

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FACULTY OF APPLIED SCIENCE AND ENGINEERING

Time: Wednesdays 1:00 - 2:30 p.m. in 1979.
Place: Room 3171 Medical Science Building

Date	Speaker	Topic
17 January	Dr. O.J.C. Runnalls Senior Advisor Uranium and Nuclear Energy Department of Energy Mines & Resources, Ottawa	"Canada's Energy Prospects"
24 January	Professor A. Feinfold Department of Mechanical Engineering University of Ottawa	"Energy — Public Policy and the Need to Know"
7 February	Prof. P.H. Oosthuizen Department of Mechanical Engineering Queen's University	"Transportation of Coal by Rail with Particular Emphasis on the Freezing Problem"

Saturday January 13
Nursing Pub at UC
January 20
Cannonball at Hart House

GODIVA WEEK

Tuesday January 16
Slave Auction 12 noon
Employment Committee Meeting
2 P.M. at the Placement Centre

Wednesday January 17
Eng. Soc. Council Meeting
5 P.M. GB 202

Friday January 19
Chariot Race - Front Campus, noon
Winterfest - Drill Hall 8 - 1

Mining for heat

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surface temperatures, on the other hand, are largely controlled by the steady flow of heat from deep within the Earth; they depend on surface temperature only through the mean rate of heat conduction away from the hot interior.

The high temperature of the interior is maintained by heat released during the radioactive decay of unstable isotopes, mainly of uranium, thorium and potassium, and it seems that the Earth is close to a steady thermal state, with the rate of heat loss at the surface approximately balanced by the rate of generation.

The rate at which the whole Earth loses heat is roughly 30×10^{12}W (watts), roughly one ten-thousandth of the rate solar energy is being supplied to it and 10 times larger than the power in the tides. This is equivalent, however, to an average surface flux of only 63mW/m² (milliwatts per square metre). This illustrates the main problem in exploiting the Earth's natural heat: although the total flux is enormous, it is dissipated over a huge area, so even with a system that collected heat with an efficiency of 100 per cent it would take an area the size of a football pitch to provide enough power for half-a-dozen domestic electric light bulbs.

This means that if the Earth's heat is to be a practical source of energy we must find places where the heat flux is a great deal above average or else use some 'heat mining' technique to remove heat from rocks more rapidly than it is being supplied to them.

At most places where geothermal power is being used the heat flux is intense. This is usually where large amounts of heat are caried to the surface by magma, or molten rock, at 1000°C or more. Such zones are found along the margins of the great rigid 'plates' which make up the surface of the Earth and which are continuously interacting, slowly moving apart, converging or sliding past each other. These regions are the focus of most of the Earth's volcanic and earthquake activity, and any country which enjoys the mixed blessing of being at or near a plate boundary may seriously consider exploiting geothermal heat.

However, it is one thing to have volcanic activity at the surface or large volumes of molten rock thrown up to the regions near the surface, thereby heating the surrounding rocks ; it is another to harness this heat to man's purposes. Some kind of heat exchanger is necessary, so water must be circulated through the hot rock and brought to the surface, at temperatures of 150°C or more, to heat another fluid which may in turn drive a turbine. *Continued next issue*

Cannonball 7T9

FEATURING Abbey Road
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and
Cannonball Queen
contests

Saturday January 20, 1979

Hart House 8:00 p.m.

Tickets $12 per couple

EH—HEMM EH—HEMM

YOUR CHANCE TO VISIT LONDON, FOR FREE!
(London, Ontario)

This year's APEO-UES conference will be held in London, Ontario January 19-21, 1979. The theme of the conference will be "Engineering in the Next 100 Years". Our hosts will be the University of Western Ontario Undergraduate Engineering Society.

With the help of the APEO, Western has been able to acpuire severol interesting and informative guest speakers. The conference will also include parties both friday and saturday nights. All meals are gratis, and hotel accomodotion is paid for in registration fees, which will be probably covered by our Eng. Soc.

Western would like the names of our four delegates as soon as possible. Therefore, if you are interested in attending, please leave a note in the Professional Development mailbox by January 12. Preference will be given to people who applied for the C.C.E.S. and to other active Eng. Soc. members, but other interested engineering students are welcome to apply. In your note, please include your name, address, phone number, course, year, and relevant Eng. Soc. and/or professional association experience, and suitoble bribes.